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*A Contribution to Cerebral Surgery.*

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upon the Surgical Treatment of  
Brain Tumors.*

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FROM

THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES,  
APRIL, 1893.



## A CONTRIBUTION TO CEREBRAL SURGERY.

DIAGNOSIS, LOCALIZATION, AND OPERATION FOR REMOVAL OF THREE  
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SURGICAL TREATMENT OF BRAIN TUMORS.<sup>1</sup>

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THE practical results from the study of cerebral localization in the successful surgical treatment of brain diseases form a subject of growing interest. Every fact which bears upon it, and every case in which an operation has been performed should be recorded, whether the result obtained be favorable or the reverse. Successful results are sure to be published. It is very desirable, however, in order that we may learn to properly estimate the dangers and difficulties that may be met with in the diagnosis and treatment of localizable disease, that all results, even those which are in some measure unfavorable, should also be made known. In this paper the surgical treatment of brain tumors is to be considered. The general results of operations hitherto recorded will be reviewed, and our own experience in three cases related.

The number of cases of tumor of the brain in which surgical relief has been attempted, so far as we have been able to find reports in current literature, and including the three cases presented here, is 87. Seventy-four of these were tumors of the cerebral hemispheres; thirteen of them were tumors of the cerebellum. The results are given in the following table:

	Cerebral.	Cerebellar.	Total.
Total number of cases operated upon	74	13	87
Cases in which tumor was not found	16	7	23
"    "    "    " found, but not removed	1	2	3
"    "    "    " removed and patient recovered	38	2	40
"    "    "    "    "    "    "    " died	19	2	21

<sup>1</sup> Read before the New York Academy of Medicine, January 5, 1893.



It will be seen that the percentage of recoveries after the successful localization and removal of the tumor is 46. Considering how recently the facts of localization have been determined, and how novel is the surgical procedure of operation upon the brain, this large percentage of successful results is both interesting and encouraging. Therefore every case in which the presence of a tumor of the brain is suspected should be studied with increased care, and the question of operation should be thoroughly considered.<sup>1</sup>

It seems best to distinguish broadly between tumors of the cerebrum and tumors of the cerebellum. The diagnosis between tumors situated in these different regions is perfectly easy, and the risk of operation is so different as to demand their separate consideration.

As shown in the table already given, 74 tumors of the cerebral hemispheres have been treated surgically. In 16 of these cases the operation was unsuccessful, either because the tumor was not found by the surgeon at the point at which it was supposed to lie, or because the operation was undertaken for the relief of the symptoms caused by intra-cranial pressure, and not with a view to the removal of the tumor (8 cases).

In some of the cases the localizing symptoms were clearly insufficient to indicate the position of the tumor, and a cautious neurologist would not have advised an attempt to find it.

In others the localizing symptoms were well marked and the diagnosis seemed clear, yet the tumor really lay at such a depth as to be inaccessible, or infiltrated the brain to such an extent as to make removal impossible.

In 57 cases out of the 74 the tumor was successfully located and removed: 38 of the patients recovered; 19 died. Of these 57 tumors, 34 were removed from the motor (central) region of the brain. It is in this region that the location of a tumor can be most easily determined, and here few mistakes in diagnosis have been made. The occurrence of spasm or of paralysis, limited to one limb or extending from one to the other in a definite order, is diagnostic. In one of the cases reported, the motor symptoms were certainly of the greatest service in determining the location of the tumor. So, too, in a case reported by Erb in July, 1892, in the *Deutsche Zeitschrift für Nervenheilkunde*. This case deserves mention on account of its unique history:

<sup>1</sup> The literature is extensive. Recent important articles are as follows: Weir and Seguin, AMERICAN JOURNAL OF THE MEDICAL SCIENCES, July, August, and September, 1888; Keen, AMERICAN JOURNAL OF THE MEDICAL SCIENCES, November, 1888; Park, "Surgery of the Brain," Transactions of the Association of American Physicians and Surgeons, 1889; Von Bergmann, Die chirurgische Behandlung von Hirnkrankheiten, 1889; P. C. Knapp, Intra-cranial Growths, 1891 (the last contains tables of all cases up to date of publication); Theodore Diller, The Pittsburg Medical Review, October and November, 1892.

The patient was a male, who had suffered for some months from the general symptoms of brain tumor, namely, headache, vertigo, vomiting, and optic neuritis. The development of occasional spasms, followed by paralysis in the left arm and leg, indicated the central convolutions of the right hemisphere as the probable position of the tumor. Czerny operated in November, 1890, and found the tumor to be an infiltrating gliosarcoma. He removed a part of it—complete extirpation being impossible. The patient recovered from the operation, and was very much improved for eight months, when he began again to suffer from the old symptoms. In November, 1891, it was thought best to repeat the operation, and again a large part of the tumor was removed. Striking improvement followed this second operation; but at the date of the last report, July, 1892, symptoms had returned, and a third operation was under discussion.

This case demonstrates the possibility of relieving the most serious symptoms and of prolonging life even when the entire tumor cannot be removed.

The location of the tumor in the remaining 23 cases was as follows: in the frontal region in 6; in the parietal region in 3; in the occipital region in 1. In the remainder the location of the tumor was not exactly stated in the histories. It is evident, therefore, that tumors have been successfully removed from almost all parts of the convexity of the cerebral hemispheres. It is impossible either to satisfactorily diagnosticate or to remove tumors lying on the median or basal surfaces, and no attempt at such removal has been made.

Surgical treatment has been attempted in 13 cases of cerebellar tumor. In only 2 cases has the operation been successful, and in 7 cases the tumor was not reached. An abstract of all these cases is given at the end of this paper, in order that the difficulties met with may be appreciated.

An operation undertaken with a view to the removal of a tumor of the brain should be especially well considered beforehand. To a much greater extent than is at all frequent in other parts of the body are these operations essentially exploratory, and in spite of the very perfect and constantly increasing knowledge of the character and localization of brain tumors, the operator will probably always be in doubt, until the tumor is reached, as to whether he will be able to remove it or not. Assuming that an accurate diagnosis has been made, and that the localization of the disease has been carefully studied by a skilled neurologist, grave doubt may still exist as to the consistency, the size, the vascularity, even as to whether the tumor is situated on the surface or buried to a considerable depth, and still more as to whether the tumor is encapsulated and easily enucleable, or so infiltrates the brain tissue as to present no definite border. Many exploratory operations in other parts of the body are extremely simple and perfectly safe, so long

as the work done is confined to the strict nature of an exploration. We enter the peritoneal cavity, explore kidneys through incision in the loin, open joints, and take sections from tumors for examination with almost entire impunity from accident, so long as nothing more than investigation be made. The reason for this safety lies chiefly in the fact that the exploratory road is not difficult, and that such difficulties as exist are appreciated beforehand and are easily overcome. This statement, however, does not apply to operations upon brain tumors. Unexpected difficulties, even serious accidents, are liable to occur at almost any stage in the operation, so that from beginning to end the exploration itself is an operation of importance. This is better appreciated when we consider the causes of death after these operations, whether the tumor has been reached and removed or not. Excluding complications not immediately dependent on the operation, death has resulted in 54 per cent. of the cases operated upon, either from sepsis, hemorrhage, or shock, or from two or all of these causes combined. Sepsis need not be especially considered, as there exists no greater difficulty in avoiding it than the surgeon meets with in other parts of the body. Most careful antiseptic precautions should be taken. The head should be completely shaved, and great attention be paid to the thorough cleansing of the scalp, the operation being postponed if it is found that a moist eczema or other discharging surface exists at any point. Hemorrhage is a most important consideration. It begins from the moment the knife touches the scalp, is enormously different in quantity in different cases, and is liable to be unexpectedly increased *at a later stage* in the operation after the patient has already lost an important quantity of blood. I am convinced that hemorrhage deserves the closest consideration on the part of the operator.

The incisions in the scalp should unquestionably be free. After opening the skull, it may be necessary to greatly enlarge the operative field, and this stage is a most unfavorable one for making first incisions in the scalp. It is best to lay bare a bone area at least three inches in diameter. The horseshoe shaped incision, or one representing more than half of a circle, is most frequently used, and is doubtless the best. Such an incision allows a large flap, including all the integuments excepting the periosteum, to be easily turned back. The hemorrhage from this incision is very active, and the means adopted for its prevention not entirely satisfactory. The use of the rubber band wound tightly about the head below the field of work is exceedingly disappointing, probably on account of the shape of the skull, the rubber band not making constriction evenly about the whole circumference. Finger pressure over the afferent vessels is also insufficient, for only a few vessels can be compressed, while, owing to the free anastomosis in the scalp, the bleeding comes from every direction. I am inclined to

think that the most practical and satisfactory method is to make the whole incision at once, immediately compressing the entire wound with dry gauze, and then lifting the gauze first at one point, and then at another, to seize the vessels in succession with pressure-forceps. With good assistance and active work the vessels can all be controlled pretty rapidly.

The next question that arises, after the vessels have been ligated and the very numerous pressure-forceps gotten out of the way, is: How shall the skull be entered? A very usual method by which the skull has been opened has been by means of the trephine, either large or small, the opening being afterward enlarged with the rongeur forceps. If a trephine less than an inch and a half in diameter be used, the opening made will not be large enough to treat any brain tumor, excepting a very small surface growth. The opening has usually been enlarged with rongeur forceps—a great sacrifice of bone, which cannot be entirely safely replaced, being thus made. If a still larger trephine is used, one has a clumsy instrument to work with, and still has a large bone defect to close. Ordinarily the button of bone had better not be replaced after the removal of a tumor, for the cavity in the brain frequently needs packing with gauze, and, besides, the button may necrose.

Having frequently made use of another method of entering the skull for extensive operations, I have no hesitation in recommending it to facilitate the removal of brain tumors. I refer to the method suggested by Wagner. It consists essentially in cutting through the skull with the chisel in the line of the scalp incision, the scalp flap not having been turned back. This bone flap with scalp flap still attached is then pried up and turned back, thus exposing as large an area of dura mater as the original incision outlined. The method is practically applied as follows: The horseshoe-shaped scalp incision having been made and all vessels caught and tied, the cut is deepened through the pericranium in the same line, so that this tissue may not be injured when working on the bone. At the centre of the convexity of the incision, the pericranium is turned back far enough to permit of the application of a half-inch trephine. This small button of bone is removed to allow of the subsequent use of the elevator. Starting from this trephine opening with a very small gouge, a shallow groove is cut following the line of incision in scalp and pericranium. Cutting this groove prevents subsequent splintering of the surface. Then with a sharp osteotome held nearly parallel with the surface of the skull, it is not difficult with the mallet to cut through the skull without injuring the dura mater, until, introducing an elevator into the trephine opening, the whole plate of bone can be pried up, the uncut portion of its circumference readily breaking. The whole plate of bone has the pericranium and scalp flap

attached, and opposite the line of fracture, even, the pericranium remains un torn. Slowly lifting the bony plate and feeling beneath it to make sure that vessels or adhesions are not rudely torn, the entire mass can be turned back and the dura exposed. If localization has been fairly correct it will not now be necessary to enlarge the opening. Hemorrhage from the bone may be, as it was in one of the cases reported, excessive; usually, it will cease after short pressure; if not, the larger vessels should be plugged either with gauze or bits of sponge or catgut. Hemorrhage from the surface of the dura is usually slight, and can be most rapidly stopped with a light touch of the Paquelin cautery, or, if one prefers, a fine curved needle threaded with catgut may be passed under the bleeding-point and the vessel tied.

To open the dura, I prefer to cut directly down upon it with the knife at a point an eighth or a quarter of an inch away from the bony margin. When an opening is made, small blunt scissors may be introduced, and the whole flap of dura, similar in shape to the bone flap, turned back. Picking up the dura mater with a tenaculum is more likely to be accompanied by a wound of a vessel in the pia mater. Of course, if the dura is adherent, the flap must be cautiously made and reflected. Color, consistency, bulging, and pulsation of the surface of the brain are now all rapidly determined. If the tumor is evident at once and clearly defined, with a capsule, its enucleation with the finger or blunt scissors is not difficult. If tumor tissue is plain, but the growth infiltrates the brain substance, it may be very difficult to decide when to stop in attempting removal. If clearly not removable *in toto*, it may still add much to life and comfort to remove a portion, as was shown in Czerny's case, intra-cranial pressure being relieved. As a rule, if removal is begun, it had better be completed, for to leave a portion of an infiltrating tumor is to leave the patient with the certainty of recurrence at an early date. If tumor tissue is not seen on the surface, its presence beneath the surface may be suspected from the prominence of, and the absence of pulsation in, the surface tissue. Palpation may define that a solid tumor exists below; or a blunt probe may be pushed in the most likely direction to see if resistance is encountered; or an aspirating-needle may be introduced to determine the presence of fluid. If a solid tumor is discovered, the convolutions over it should be separated or the brain should be incised, as may be necessary, and removal effected, if possible by enucleation. If a cystic tumor is found, it should ordinarily be incised and drained. Drainage can best be effected by the introduction through the incision of a narrow strip of thin rubber tissue which has been folded once or twice upon itself. Fluid flows out by the side of this material perfectly well, and the thin and flexible tissue is incapable of doing harm if thoroughly aseptic. Wounded vessels in the pia mater may be quite troublesome, not so much from the quantity of blood lost as from the amount

of time lost in attending to them. Their walls are so delicate that the ligature is applied with difficulty. A light touch with the cautery is the quickest way of disposing of the smaller ones, and the larger ones may be compressed by a bit of sponge in the hand of an assistant, and the cautery or a ligature applied, if necessary, later. The wounding of one of the large venous sinuses, or of a vein near the point of entrance into a sinus, is sure to be followed by abundant hemorrhage. If the wound in a sinus is large, it had best be immediately packed with gauze. If it is small enough to be closed by one or two pairs of pressure-forceps, these may be applied, and left in position supported by the dressings for two or three days. It is useless and time-consuming to try to ligature or sew up a wounded sinus.

Free hemorrhage from the cavity left after removal of a tumor should be met by immediate compression with gauze packing, which may be left in place, if necessary, until a change of dressings is made. In operating for tumor in the cerebellum, the method last recommended for entering the skull is hardly applicable. The area is too small and the danger of wounding the sinuses too great to allow of the lifting of a bony plate with the thick flap of soft coverings. It is better here to sacrifice the bone, making a small, safe opening with trephine or chisel opposite the centre of the fossa, and then enlarging the opening on all sides with forceps. The fact that the present knowledge of cerebral localization does not enable us to decide whether a cerebellar tumor is a surface or a deep one, renders these operations more especially exploratory. Whether it is safe or justifiable to cut away a considerable portion of cerebellum, in order to reach a deep-seated tumor in this region, further experience is needed to decide.

If a tumor has been found and removed, the dura mater would probably be only partially stitched back into place by fine catgut stitches, as to completely close a cavity in the brain in which bleeding was still going on would subject the patient to the dangers of compression. Therefore, usually packing would at first be left in place, or other drainage provided for. If a tumor is not found and no contra-indication to complete closure exists, the dural flap may be replaced and stitched all the way round to the narrow border left for that purpose. The advantage of the large single bone flap is now readily appreciated. The osseous plate with pericranium undisturbed and integument undissected is turned back into place and fits accurately. The skin may be stitched all the way round or not, according as drainage must be provided for or is not needed. The small trephine opening is there if a drain is required. If packing has been introduced, the bony plate may be left partly raised like the lid of a box, and only pressed into place after the packing has been removed.

The question of hemorrhage has been referred to in detail, because

blood loss in itself has undoubtedly not a little to do with the death-rate after operations for brain tumors. Bleeding is met with in most cases at every stage in the work, and not only may the sum of the loss be considerable, or even very large, but every moment spent in attending to it prolongs the operation, and so directly contributes to inducing the third cause of fatality mentioned, namely, shock. The length of time occupied and the size of the tumor bear a direct relation, as in the surgery of other parts of the body, to the amount of shock developed. Every effort should, therefore, be made to shorten the time occupied in operating, as the size of the tumor will be accurately known only at a late stage in the operation. No especial means either for the prevention or treatment of shock from operations upon brain tumors exist, other than those with which every surgeon is familiar when he meets with this condition under other circumstances.

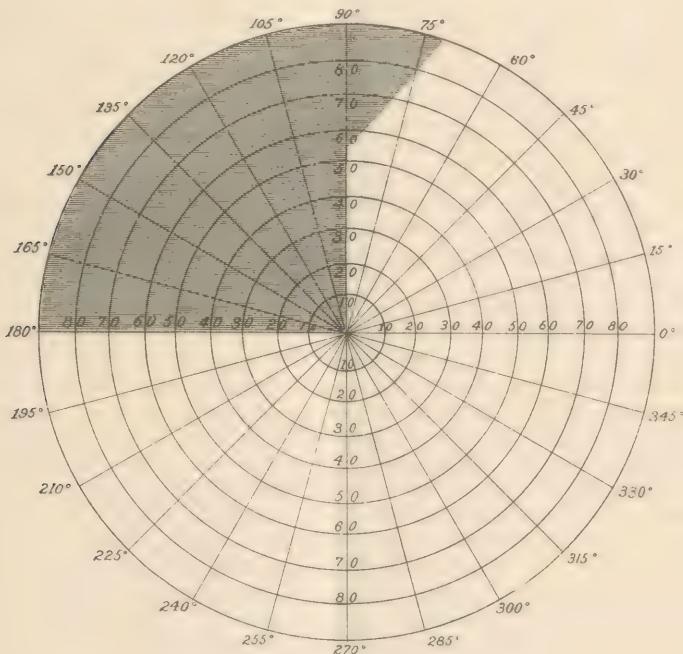
*CASE I. Sarcoma of the left frontal lobe; mental and motor symptoms; successful localization and removal; subsequent death.*—C. S., aged forty, a farmer by occupation, of good family history, and of good general health until this illness (with the exception of specific disease acquired at the age of twenty-two, but without subsequent manifestations), was suddenly seized with a convulsion in December, 1890, while driving a cart. He remembers a sudden feeling of dizziness and distress, and then a turning of his head forcibly to the right side; he has no recollection of what followed, but learned that he had been found upon the road, had been picked up and carried home, where he remained unconscious for two hours and a half; he is not sure whether he had a general convulsion. On recovering consciousness he found his right side, including face, arm, and leg, slightly weak, and noticed some difficulty in talking; this condition gradually subsided, so that in two weeks he was able to go back to his work, and felt in his usual health. This is the only convulsion or sudden attack of any kind which occurred during his entire illness. But it is from this attack that his illness dates.

The various symptoms which subsequently developed were very gradual in their onset, so that it is quite impossible to fix any dates for particular symptoms. During the six months from January, 1891 to July, 1891, he suffered occasionally from headache and nausea, and in July began to notice that his sight was growing dim, and that the headaches were becoming more and more frequent and intense. Between July, 1891, and January, 1892, the pain became localized over the forehead and top of the head on the left side; it was not particularly worse at night, but at times was very severe. During this period he noticed a progressive dulness of thought, general hebetude, an aversion to work which was unnatural to him, and a slowness of mental activity which he described as increasing stupidity; and increasing difficulty in the use of language, so that it took him longer to express his ideas, there being, however, no difficulty in articulation and no lack of words.

He also noticed by the close of the year that his right side had become a little weaker than his left side; that his hand was slightly awkward and that his leg felt a little heavy. The symptom, however, which caused him most distress, was his gradually increasing dimness of vision,

and it was on account of this that he came to New York from his home in Alabama. He was seen at the New York Eye and Ear Infirmary by Dr. Derby, who discovered a well-marked condition of optic neuritis in both eyes, more marked in the left eye. V.: O. D., = 20/L.; O. S., = 20/xx. In right eye the upper and inner quadrant of visual field wanting. Dr. Derby referred him to the Nervous Department of the Vanderbilt Clinic for confirmation of his diagnosis of cerebral tumor, and also for treatment.

FIG. 1.



CASE I.—The visual field of the left eye.

When I first saw him at the clinic on January 14, 1892, the following symptoms were present: severe and constant *frontal headache* located over the top of the head, and more especially over the left side, about at the upper third of the coronal suture, and at this area, over a space about three inches in diameter, there was considerable *tenderness to percussion*. There was no vertigo on rising or on change of position. There was a state of *partial blindness* due to the very well marked condition of *optic neuritis*, and decidedly worse in the left eye.

There was a condition of *mental dulness* which was noticeable, and which he himself and a friend who accompanied him insisted was wholly unnatural. This dulness consisted in a slowness of thought, which made him appear very stupid. It took him some time to appreciate the meaning of questions, and it was an effort to answer them. This effort was not due to any actual disturbance of speech, any loss of words, or any difficulty in pronunciation, though he complained that he

could not talk as fluently or rapidly as heretofore. The condition was therefore in no sense an aphasic one, but could only be spoken of as a slowness in mental processes. His comprehension was good and his conclusions were correct, when he had time to think, but rapid mental action was impossible, and if insisted upon he became confused and would say that he could not think. Hence he distrusted his own mental power, and said that he did not think that his judgment was as good as formerly. He was disinclined to occupy himself in any way, and sat in a listless manner, saying nothing for hours at a time. He would often sleep in the daytime, though at night his sleep was often broken by his pain. It was not easy for him to hold his attention to any subject continuously for any length of time. His mental state might be termed a dull listlessness, and gave the impression that he was a sick man.

Careful examination detected the existence of a *slight right hemiplegia*; his face was slightly flattened and slow in motion on the right side; his hand was somewhat awkward and clumsy, the power being 140 by the dynamometer, that on the left being 160. He dragged the toe slightly in walking, though his gait was not noticeable. He had great exaggeration of the knee-jerks and marked ankle clonus. He complained of a feeling of numbness, both in the hand and foot, but there was no objective anaesthesia.

*Diagnosis.* From these symptoms a diagnosis was reached of a brain tumor. The situation of the tumor was not easily determined. The slight right hemiplegia indicated that it was in the left hemisphere of the brain, near to but not within the motor region. The hemiplegia had appeared long after the other symptoms, hence it was evident that the motor zone had been only reached when the tumor had become large. The position of the headache and of the tenderness to percussion over the frontal region, and the existence of the mental symptoms described, appeared to indicate the frontal lobe as the probable situation. This was confirmed by the absence of anaesthesia or of hemianopsia or of sensory aphasia, all of which conditions would have been likely to have been present in a tumor situated near to but behind the motor zone in the parietal lobe. The mental symptoms were considered of very great importance in the diagnosis of a frontal lobe lesion.

A study of twenty-three cases of disease of the frontal lobes of the brain,<sup>1</sup> made by one of us in 1884, showed that decided mental disturbance occurred in half of the cases. At that time the following conclusions were reached: "The form of mental disturbance in lesions of the frontal region does not conform to any type of insanity. It is rather to be described as a loss of self-control and a consequent change of character. The mind exercises a constant inhibitory influence upon all action, physical and mental, from the simple restraint upon the lower reflexes, such as the action of the sphincters, to the higher control over the complex reflexes, such as emotional impulses and their manifestation in speech and expression. This action of control implies a recognition of the import of an act in connection with other acts; in a word, it involves

<sup>1</sup> Starr: "Cortical Lesions of the Brain," THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES, April, 1884.

judgment and reason, the highest mental qualities. By inhibiting all but one set of impulses it enables one to fix the attention upon a subject and to hold it there. It seems probable that the processes involved in judgment and reason have, for their physical basis, the frontal lobes; if so, the total destruction of these lobes would reduce man to the state of an idiot; their partial destruction would be manifested by errors of judgment and reason of a striking character. One of the first manifestations would be a lack of that self-control which is the constant accompaniment of mental action and which would be shown by an inability to fix the attention, to follow a continuous train of thought or to conduct intellectual processes. It is this very symptom that was present in one-half of the cases collected. It occurred in all forms of lesion: from injury by foreign bodies, from destruction by abscess, from compression and softening due to the presence of tumors, and, therefore, cannot be ascribed to any one form of disease. It did not occur in lesions of other parts of the brain here cited. But its presence in such a large number of these cases warrants the suggestion that in cases of suspected lesion of the frontal lobe, the mental condition of the patient as shown by his acts of judgment and reason should be carefully examined, and a change of character or behavior accurately noted."

Ferrier, in his Croonian lectures in 1890, again called attention to the occurrence of such mental symptoms in connection with diseases of the frontal lobes.

Welt (*Alienist and Neurologist*, April, 1890) concluded from a study of eight cases under his observation, that changes in character and disposition are characteristic of lesions in the frontal lobes. He says they may be the only symptoms present.

W. Gilman Thompson (*Medical News*, May, 1891) has described changes in temperament and alterations in the intellectual sphere occurring in three cases of tumor of the frontal lobes under his observation.

Schoenthal has also recorded a case diagnosticated as hysteria on account of the mental peculiarities and lack of self-control, in which a large tumor of the frontal lobe was found after death.

Griffith and Sheldon (*Journal of Mental Science*, 1890, p. 223), in reporting a case of tumor invading the median surface and base of both frontal lobes, in which mental symptoms were absent, call attention to the fact that mental symptoms occur chiefly when the cortex of the convexity of the frontal lobes is invaded; and this statement is borne out by my own collection of cases before alluded to.

The review of these cases, therefore, pointed to the conclusion that mental symptoms are likely to be produced by a tumor in the frontal region, and this fact was considered of much importance in determining the situation of the tumor in this case.

The diagnosis of the nature of the tumor was somewhat difficult. The existence of specific disease pointed to gumma, and made it seem proper to try the effect of specific treatment; he was therefore put on inunctions of mercury and increasing doses of iodide of potash, which was carried to the point of three hundred grains a day. This treatment was pursued without much apparent change in his condition. He then escaped from my observation for two months, but returned about the first of June to the clinic.

It was then found that his headache was still severe, was still localized in the left side of the forehead. It was found that his sight was much worse, so that he was nearly blind in the right eye and could not read letters with the left eye. His hemiplegia was more marked; his face was flatter on the right side; his arm and hand more clumsy, and there was a decided dragging of the right foot. He complained that his right leg was getting stiffer all the time and that it felt dead. He said that he had recently been having twitching in the right leg, as often as two or three times a day. He also said that at times his hand became clenched without his power to resist it, but he denied the existence of any clonic spasms. He had had some difficulty in micturition during the past months, it being impossible for him to control his bladder perfectly, the urine flowing unexpectedly. His speech was slower, and there was a noticeable tendency to the malposition of words in sentences, which, however, he noticed himself and corrected; he would often say "no" for "yes," and *vice versa*. His mental activity was evidently much weaker than it had been five months before.

Under these circumstances it seemed evident that specific treatment had failed of effect, and he was induced to enter Roosevelt Hospital and submit to an operation.

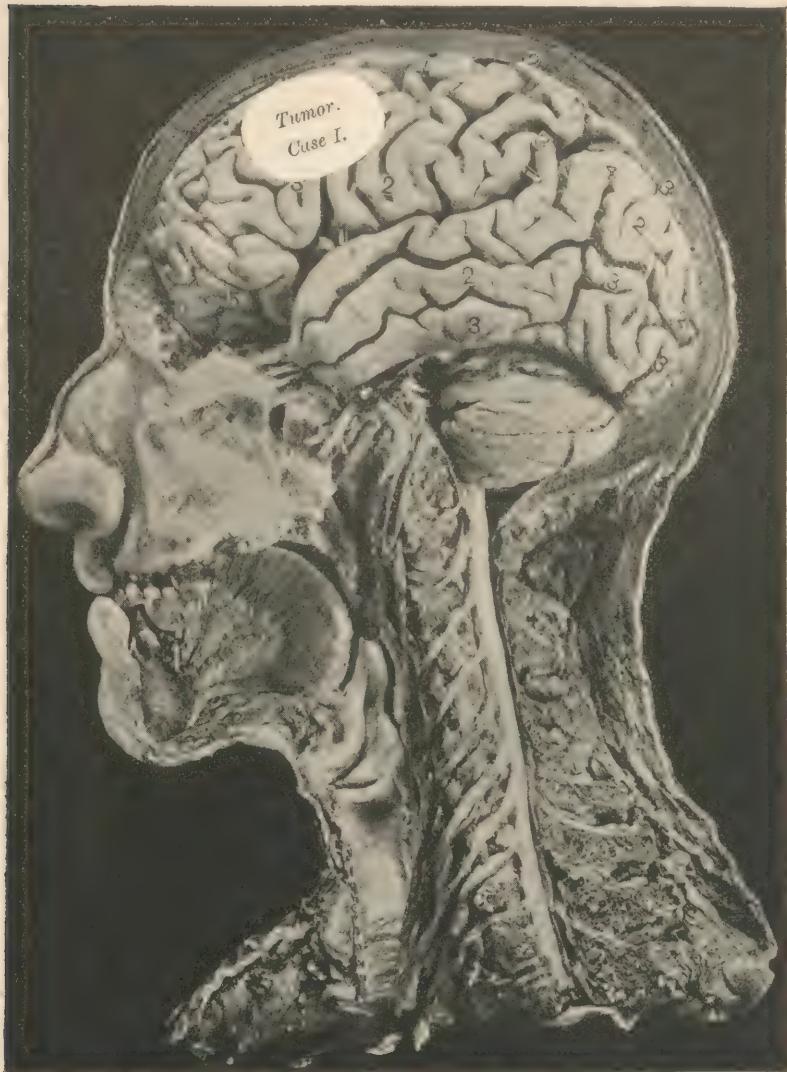
*Operation.* The operation was performed by Dr. McBurney on June 23, 1892. Ether anæsthesia. A semi-elliptical incision was made in the scalp, outlining an area which measured about three inches in each direction, the attached base of the flap being below. The centre of the flap coincided with a point an inch and a half anterior to the fissure of Rolando, opposite the junction of its upper and middle thirds.

The tumor was believed to occupy the posterior part of the second frontal convolution, just anterior to its junction with the anterior central convolution. The hemorrhage caused by this incision was excessive, certainly treble the usual amount, and required a large number of pressure-forceps and ligatures for its control. A button of bone, one inch in diameter, was then removed with the trephine from the centre of the area exposed by turning down the flap. This opening was enlarged with rongeur forceps downward and forward until it measured two inches by one and three-quarters. (Fig. 3.) The dura appeared to be thickened and was unnaturally pale, but pulsation seemed normal and no bleeding was noted. Profuse hemorrhage occurred from the veins of the diploë, and no little difficulty was met with in its management. The largest of these veins were occluded only by plugging their orifices firmly with small bits of sponge.

The dura mater was then incised near the edge of the opening in the bone and turned down as a flap. It was quite adherent to the surface of brain beneath it, which was uniformly dark in color and very vascular. At the first inspection the surface seemed to be that of a much-congested ordinary cortical substance. It was, however, firmer in con-

sistence than was normal, and a good-sized section was removed with the knife; it was then clear that the whole area exposed was tumor

FIG. 2.



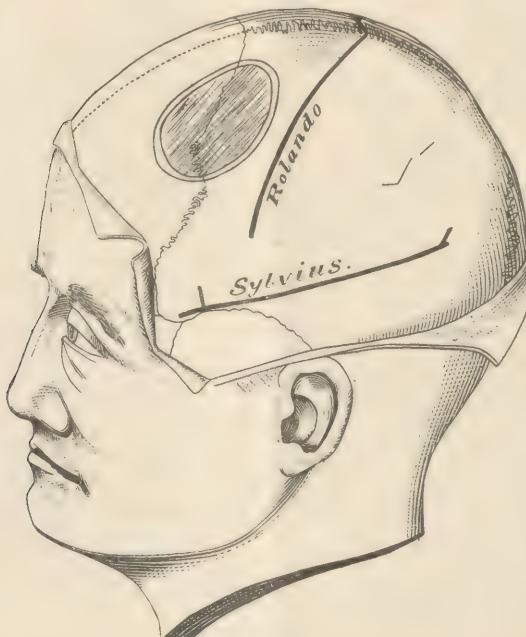
Situation of a tumor, shown in a photograph from Fraser's *Guide to Cerebral Operations*. The size is in exact ratio.

tissue. At the end of the section removed, a distinct capsule was met with; following this with finger and blunt scissors, it was not diffi-

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cult to completely enucleate the large tumor, which extended in every direction beyond the edges of the opening already made in the skull. (Fig. 3.) The tumor was ovoid in shape, measuring two and one-half by one and three-quarters inches. (Fig. 4.) It was completely enclosed by a capsule, and after its removal a large cavity in the cortex remained. This cavity bled profusely at every point; the hemorrhage requiring for its control complete packing with iodoform gauze. The flap of integument was partially replaced and sutured at the sides only, a large, loose antiseptic dressing being applied over all.

FIG. 3.



Loss of blood and shock produced a marked effect upon the patient's general condition before the close of the operation, and both rectal and hypodermatic stimulation were actively applied, and after the patient's removal to bed he was given constant attention and every effort was made to improve his condition. After a large intra-venous infusion of normal salt solution temporary marked improvement was noted, but the pulse soon failed again and death occurred about midnight, eight hours after operation.

The exact situation occupied by the tumor is shown in Fig. 5. It involved the posterior part of the second frontal convolution, the adjacent portion of the first frontal, and the upper half of the anterior central convolutions. The entire anterior central convolution must have been compressed to some degree, and indirect pressure must have been exerted upon the third frontal convolution below the tumor. The situation of the tumor corresponded, therefore, very accurately to the

FIG. 4.

1 inch.

2 inches.  $2\frac{1}{2}$  inches.

The tumor in Case I. With inch measure.

FIG. 5.

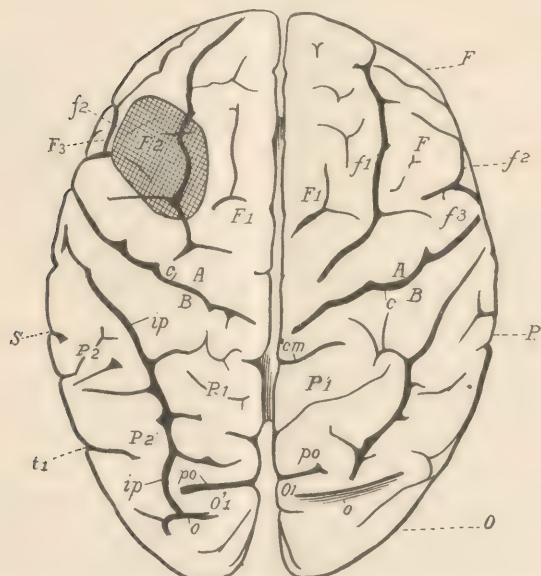


Diagram of the superior surface of the brain, to show the situation of the tumor in Case I.

diagnosis made before operation, but the size of the mass was much greater than had been anticipated. After hardening in Müller's fluid and alcohol, it displaced 50 c.c. of water, weighed 4 grammes, and measured  $2\frac{1}{2} \times 2 \times 1\frac{1}{2}$  inches. The tumor was carefully examined by Dr. Eugene Hodenpyl, and was reported by him to be a true sarcoma, consisting of a large number of delicate bloodvessels and rather large irregular, but not branching, cells closely packed together with very little intercellular substance.

An earlier operation, when the tumor was much smaller and the vascularity of the tissues much less, would very probably have been successful. It was proposed to the patient in February, four months before it was done. The delay, which he insisted upon, was more readily submitted to because of his specific history, which induced us to give him the benefit of the doubt and to try anti-syphilitic treatment. If Horsley's dictum had been accepted, namely, that gumma is not curable by medicine and should be operated for (a dictum, however, which the experience of others in several cases does not support), an earlier operation would perhaps have been undertaken. The size of a brain tumor has undoubtedly much to do with determining the amount of shock resulting from its removal.

This tumor was about as large as one removed by Dr. Keen and described in THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES for November, 1888, and another operated upon by Prof. E. Hitzig, an account of which was published in the *Berliner klinische Wochenschrift* for July 18, 1892.

**SUMMARY.**—In this case the diagnosis of the tumor of the brain was made from the general symptoms—headache, optic neuritis, and tenderness to percussion of the head, and from the local symptoms—mental dulness, slowness of speech, slight right hemiplegia with subjective numbness and occasional twitching in the paralyzed limbs. The situation of the tumor was determined by the slow onset of the hemiplegia, by the very marked mental symptoms, and by the location of the tenderness upon the head. Attention has already been called to the value of the mental symptoms in the localization of the tumor, and no further comment upon them is necessary. This is the first case, however, in which operative interference has been so distinctly directed by the existence of mental symptoms.

It is interesting to note that the first symptom in this case was a convulsion beginning with a turning of the head and eyes to the right. The motor centres for movements of the head and eyes have been located by Horsley at the posterior part of the second frontal convolution, and it was exactly in this region that the growth must have commenced. The absence of serious paralysis at any time—for the man was perfectly able to walk, to feed himself, or even to write, up to the day of the operation—shows that the pressure upon the motor zone of the cortex was not sufficient to arrest its function. And it is interesting to observe that this pressure having been exerted very gradually did not at any time induce

cortical spasms, for the slight twitching of hand and leg, which were complained of late in the history, were not of the nature of Jacksonian epilepsy. The tumor lay upon the cortex in a capsule of its own, and did not produce any apparent pathological changes in the cortex itself, though this supposition could not be confirmed by microscopical examination. There was no evidence of softening or encephalitis. The amount of pressure or compression which the cerebral tissue will admit without manifesting evidence either of irritation or of arrest of function was peculiarly illustrated in this case. The situation was exactly such as to have caused agraphia, had the theory of a motor centre for writing independent of the hand centre been correct, but there was no agraphia present.

Tumors of the cerebellum are not at all infrequent, and, as a rule, are easily diagnosticated. The following histories illustrate the symptomatology of the disease, and the difficulty in the way of its exact localization in the cerebellum and in the way of surgical interference for the removal of tumors of the cerebellum.

*CASE II. Fibro-sarcoma of the cerebellum and pons Varolii; staggering away from the side of the tumor; operation; death.*—Male, aged thirty years; was under my observation from January, 1890, until December, 1891, when he died. He was referred to the Nervous Department of the Vanderbilt Clinic by Dr. Weeks. When first seen he was suffering from severe frontal and occipital headache; from vertigo, which was much increased by moving the head suddenly, or by lying down; from tinnitus aurium; from numbness in the left side of the face and in the mouth; and from a very continuous feeling of drowsiness and dulness. These symptoms had developed gradually during the preceding three years, and within a year he had also noticed double vision and a gradually increasing blindness. His friends said that his speech had become slow and thick.

Examination showed a large, very dull, stupid man, with prominent eyes, the left one deviating outward, dilated pupils, and marked nystagmus on lateral movement of the eyes. Dr. Weeks had found well-marked choked disks and a diminution of the visual fields. There was some slowness of speech, which was accounted for by his mental dulness, there being no evidence either of aphasia or of paralysis of the tongue. There was no disturbance of sensation, or of motion, or of reflex action, and there was no ataxia in his gait. The existence of headache, vertigo, tinnitus aurium, nystagmus, diplopia, and choked disks established the diagnosis of a cerebral tumor, but no conclusion regarding its localization could be reached. That the tumor was not a gumma was admitted, as he denied all specific infection, yet he was put upon mercury and iodide of potash on the supposition that he might have acquired the disease without his knowledge.

During the year 1890 the symptoms continued, and gradually increased in intensity, so that by the first of October he had become quite blind, with well-marked optic atrophy; and also deaf in the left ear, in which ear the tinnitus aurium had been intense. By this time, also, local

symptoms had developed, which gave an indication of the site of the tumor. There was a considerable degree of staggering in walking, with a tendency to fall forward and toward the right, and a marked tendency to turn toward the right in walking. In addition, there was some weakness in his right hand, the dynamometer registering only 39, while it registered 60 in the left hand. There was no ataxia or disturbance of sensation in the limbs. There was no apparent difference in the power in the legs, but the knee-jerk was exaggerated on the right side, and a slight clonus was obtained in the right foot.

The staggering was of the kind observed in cerebellar disease—a gait like that of a drunken man, without falling, but with every appearance that the balance was uncertain. The tendency to turn and to fall to the right was noticed on every occasion on which he was tested.

*Diagnosis.* The staggering seemed to prove that the disease was located in the cerebellum, and the question arose whether its direction, toward the right, pointed to the side on which the tumor lay. Ross makes the statement that staggering is toward the side of the tumor. Out of eighteen cases of cerebellar tumor in which staggering toward one side was observed during life, which I have been able to find after careful search in the literature, fourteen were found to have had the tumor on the side opposite to the staggering—*i. e.*, 77 per cent.—and four were found to have had the tumor on the side toward which the patient staggered. While staggering is a symptom commonly found in cases of cerebellar tumor, staggering in one particular direction is a symptom by no means frequent, being recorded in but three cases in a collection of ninety-six cases of tumors of the cerebellum in children, made by me three years ago, and in only nine of Bernhardt's ninety cases. It is certainly more commonly observed when the disease involves one of the middle peduncles of the cerebellum, and therefore has been recorded in some cases of tumors upon the base involving the side of the pons Varolii. But here, also, there seems to be no absolute rule. I have recorded<sup>1</sup> two cases of unilateral disease of the pons with marked unilateral cranial nerve palsies in which the patients staggered toward the side of the lesion; but there are other cases on record in which the staggering was away from the lesion.

The most recent investigations upon the physiology of the cerebellum are contained in the elaborate work by Luciani, published last year.<sup>2</sup> In regard to the symptoms of rotation produced by the destruction of one-half of the cerebellum, he says that rotation may be of two kinds: the first due to irritation, the second due to paralysis.

1. Irritative rotation is caused by traumatism or an inflammatory condition of the peduncular fibres. It consists in rotation from the

<sup>1</sup> *Familiar Forms of Nervous Disease*, pp. 119-123.

<sup>2</sup> L. Luciani: *Il Cervelletto*, Firenze, 1891. Deutsche Ausgabe von Dr. M. O. Fraenkel Leipzig, 1893.

wounded toward the sound side, for in this instance the want of equilibrium is generated by a unilateral exaggeration of the cerebellar influences transmitted by the irritated peduncle.

2. Paralytic rotation is caused by the simple section of a peduncular strand. It consists in rotation from the sound toward the wounded side, because here the want of equilibrium arises from the fact that one-half of the centres in connection with the wounded peduncle suddenly lose their cerebellar influences, whilst others retain it.

In the light of these experiments, and the conclusions from them, it is evident that in those cases in man in which the patient has staggered away from the lesion, the condition has been one of irritation, while in those cases in which the patient has staggered toward the lesion the condition has been one of destruction in the middle peduncle of the cerebellum. It is as yet impossible, however, during life to determine from the symptoms, in any individual case we are dealing with, whether there is irritation or destruction of the cerebellar peduncle, and therefore, as already observed from the direction of the staggering, any positive conclusion as to the location of the disease cannot be reached.

While the staggering in this case indicated that the cerebellum was affected, its direction to the right was not considered sufficiently diagnostic to decide absolutely the question regarding which side was involved, though it pointed strongly to the left side.

That question seemed, however, to be decided by a study of the other symptoms. The patient had complained early in the disease of pain and numbness in the left half of the face, though at no time did examination show any anaesthesia. He also had much tinnitus in the left ear, which had been followed by progressive deafness. His headache, which had, at first, been frontal, was later referred with much constancy to the left occipital region, and in speaking of it he habitually put his hand back of his left ear. The weakness of the right hand and the exaggeration of the spinal reflexes on the right side, taken in connection with these left cranial nerve palsies, appeared to indicate some pressure on the left side of the pons and medulla.

Thus the staggering to the right, the left cranial nerve palsies, and the right hemiplegia, all pointed to a lesion in the left side of the posterior cranial fossa.

The diagnosis was therefore made of a tumor on the left side of the cerebellum. The negative result of specific treatment indicated that it was not a gumma, and the very slow progress of the case indicated that it must be a slowly forming tumor, probably sarcoma, inasmuch as such tumors are more common than any other kind.

During the following year, from October, 1890, to November, 1891, the patient was seen occasionally, being apparently in a stationary condition. Finally he was induced to enter the Roosevelt Hospital for operation. And he was then quite willing to submit, though knowing

the dangers, because his life was a burden, for he was blind and partly deaf, and suffering from severe headache, vertigo on any movement, and such exaggerated staggering that he could not go about. A careful examination in the hospital on December 1, 1891, confirmed the existence of all the symptoms hitherto mentioned, but failed to elicit others.

*Operation* by Dr. McBurney on December 3, 1891. Ether anaesthesia. A vertical tongue-shaped flap was marked out with the knife over the left half of the occipital bone. The upper free convex border of this flap corresponded nearly to the superior curved line of this bone. The attached base was on the back of the neck, about opposite the second cervical vertebra. The incision was carried down to the periosteum, and all the coverings were removed in one flap. Experiments on the cadaver had satisfied the operator that the safest and most convenient method of entering the cerebellar fossa was by the use of the chisel and mallet. This method was adopted here, and an opening about one and a half inches in diameter was made through the thin bone, care being taken to be far enough away from the large venous sinuses. The dura mater was not diseased, but bulged very strongly through the opening in the skull in such a manner as to at once suggest great intracranial pressure. Protrusion of cerebellar tissue was still more marked after the dura had been turned back as a flap from over its surface. Otherwise, however, the surface of the cerebellum was normal in appearance, and palpation failed to give evidence of the existence of tumor. It was found to be quite easy to introduce the finger for some distance into the skull on all sides of the cerebellar hemisphere, to thus examine a large part of its surface, and to distinctly palpate the lateral and vertical sinuses. But nowhere could the existence of tumor be demonstrated. So much protrusion of cerebellar tissue existed that it was necessary, in order to close the opening in the skull at all satisfactorily, to shave off the excess, which was done with the less compunction, as even the gentle manipulations practised had somewhat injured the delicate surface convolutions. Hemorrhage throughout the operation was very moderate and easily managed. The flaps of dura mater and overlying soft parts were then replaced, fastened in all deep parts with catgut, the skin wound being sewed completely with silk. A wet bichloride gauze dressing was applied over all, and the patient was removed to bed in excellent condition.

Convalescence was perfectly satisfactory, and on December 9th, six days after operation, the temperature being  $99^{\circ}$  and the pulse 100, the dressing was changed for the first time. Primary union was found throughout the whole extent of the wound, and all sutures were removed.

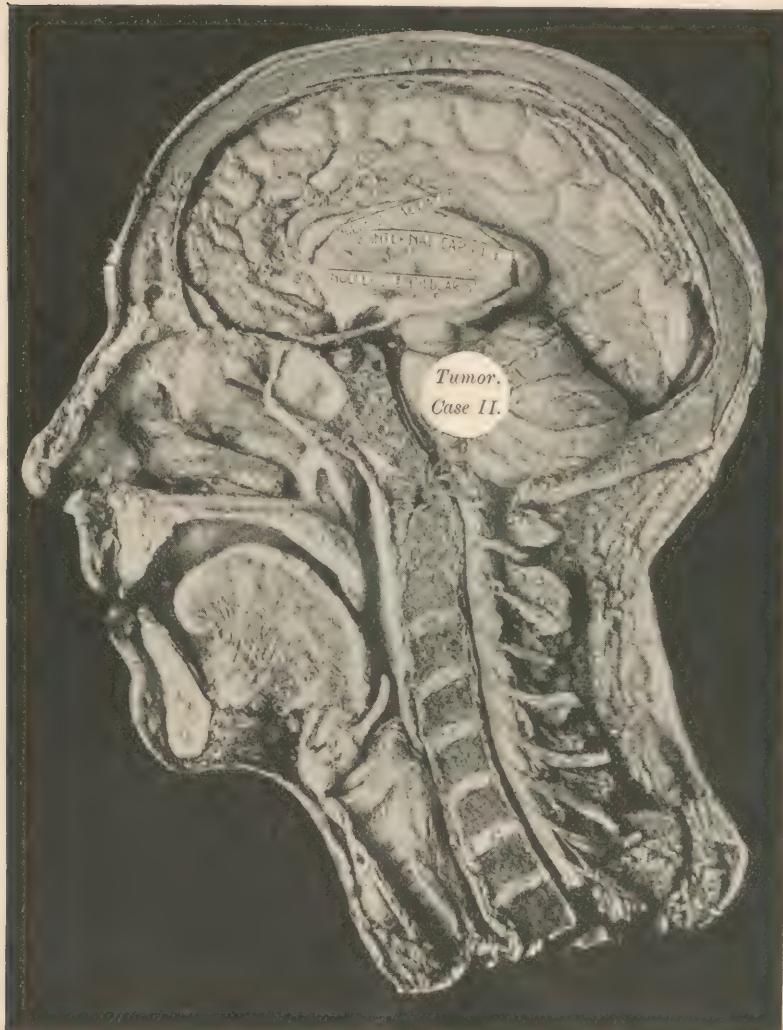
During the following night the patient fell out of bed, and immediate examination revealed the presence of a large blood-clot beneath the skin flap. No other injury seemed to have resulted from the fall, but at 5 P.M. on December 10th a chill occurred, followed by a temperature of  $103^{\circ}$ .

Difficulty in swallowing was then noted, and although at the end of two days the temperature fell to  $99^{\circ}$ , stupor gradually increased and involuntary evacuations of rectum and bladder began. The wound remained aseptic throughout, but the stupor deepened into coma, and the patient died on December 15th with a temperature of  $105^{\circ}$ .

The *autopsy* showed the presence of a tumor, a gliosarcoma, whose

limits were quite distinct from the cerebellar tissue, though it was not encapsulated. (See Fig. 6.)

FIG. 6.



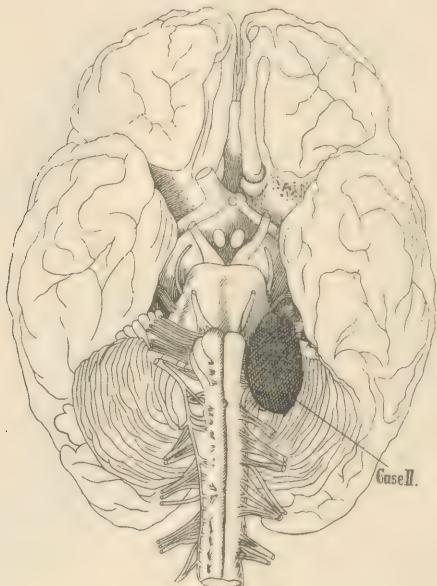
The situation of the tumor in Case II., shown on a Fraser photograph. The difficulty of removal is evident from its deep situation.

It lay on the base, and compressed the left hemisphere of the cerebellum, and especially its anterior inferior (ventro-cephalad) surface, and also pressed upon the left half of the pons Varolii at its lateral part. The left crus was slightly indented by the tumor, and the fifth nerve had been flattened out by it without being so pressed upon as to be

degenerated. The auditory and facial nerves were also compressed by the lower part of the tumor. (See Fig. 7.)

The situation of the tumor was such as to have made it absolutely impossible to reach it by operation, unless, indeed, the certainty of the situation of the tumor had been so complete as to justify full section of the cerebellum. It was almost identical in situation and appearance with a tumor reported by Wollenberg in the *Arch. für Psych.*, xxi. p. 791. Its situation as related to the surface is shown in Fig. 6, which is made by drawing the tumor in one of Alexander Fraser's plates.

FIG. 7.



**CASE III.** *Glioma of the cerebellum; characteristic staggering; operation; death.*—A little girl of seven years of age had suffered for a year from severe headache all over the head, but chiefly in the forehead, from severe vomiting, and from gradually advancing blindness, due to a progressive optic neuritis. For three months before she was seen, it had been difficult for her to walk on account of a tendency to stagger and on account of dizziness, which was undoubtedly due in part to nystagmus, which was observed early in the history. The staggering was very marked, so that during the last month she could not walk without aid. She did not appear to stagger in any one direction constantly, but there was some tendency to fall backward and slightly to the left. She complained at times of earache in the right ear, but there was no evidence of cranial nerve palsy or of hemiplegia.

The diagnosis of cerebellar tumor in this case was quite evident, but the only clue to the position of the tumor was the tendency to stagger backward and to the left. It was thought probable that the tumor was in the vermicular lobe of the cerebellum, more likely upon the right

than upon the left side. The absence of cranial nerve symptoms showed that it was not near the base. The operation was therefore undertaken.

*Operation.* The operation was done by Dr. McBurney on December 29, 1891. Ether narcosis. A horseshoe-shaped incision with the convexity upward was made over the right half of the occipital bone. The upper part of the incision lay a little above the superior curved line of the bone, and the flap, which was then turned down, included all of the soft tissues excepting the periosteum. The base of the flap was left attached to the upper part of the neck.

With chisel and mallet a considerable plate of bone was removed from over the centre of the cerebellar fossa, and the opening was then enlarged with rongeur forceps as much as was safe, having due regard for the venous sinuses. The dura protruded forcibly, but otherwise appeared normal. A large flap of dura was then cut and laid back, revealing only normal cerebellar convolutions. Examination of the sides and under surface of the cerebellum gave no information. A probe was then passed some distance, about one and a half inches, into the brain substance, but no abnormal resistance was encountered.

An aspirating-needle introduced about one-half inch from the median line, and parallel with the base of the skull, entered a cyst from which two drachms of clear serous fluid were withdrawn.

A second introduction of the needle failed to detect the cyst, and it was deemed unwise to make further exploration. The flaps were then replaced, being stitched deeply with catgut and superficially with silk. Hemorrhage during the operation was not troublesome, but before its close the patient showed the effects of shock. She rallied well, however, after rectal stimulation, and on the day following operation seemed about as well as on the day before it; at intervals complaining of headache only. Two days later complaint was made of pain in the ears; the wound was dressed and found to be aseptic. The temperature since operation had remained normal.

On January 4th, six days after operation, vomiting occurred repeatedly, the pulse became very weak, stimulation had no effect, and the patient died suddenly in a convulsion at midnight.

The *autopsy* revealed a large gliosarcoma,  $2\frac{1}{2}$  by 2 by 1 inch, which occupied the vermiciform lobe of the cerebellum and extended into both hemispheres, chiefly into the right one. It lay just under the superior surface of the cerebellar cortex; but it nowhere reached the surface of the cerebellum. It projected downward, compressing the fourth ventricle. Its consistence was about that of the cerebellum, and in its centre was a cyst which had been evacuated by the aspiration.

Certain comments upon these two cases seem warranted. First: *As to the diagnosis.* It is easy to diagnosticate cerebellar disease—headache, vomiting, vertigo, blindness, and staggering being the symptoms almost uniformly found. It is as yet almost impossible to locate the disease accurately within the cerebellum. In 16 cases out of 20, that is, in four-fifths of all cases recorded, the staggering, when uniformly toward one side, has been away from the lesion; yet in one-fifth of the cases and in several cases of disease in the pons Varolii involving the basal

surface of the cerebellum, the staggering has been toward the lesion. From the direction of the staggering alone, therefore, it is impossible to determine exactly the side of the disease. The symptoms of the greatest importance in the location of cerebellar disease appear to be those arising from the involvement of the cranial nerves upon the base. The disease commonly lies upon the side upon which these cranial nerves are affected. Such symptoms are usually due to direct pressure upon nerves on the base. They are sometimes due to displacement of the entire cerebellar axis by indirect pressure from a distance. If the cranial nerve symptoms are on the side away from which the patient staggers, then there appears to be a double probability that the tumor is on the side on which they appear. This was the condition in my first case, and the autopsy proved the truth of the probable diagnosis. The complete absence of cranial nerve palsies indicates that the tumor is not near the base. As staggering only occurs when the vermiform (middle) lobe is invaded by the tumor, its absence would show that the tumor did not lie near the median line.

The localization of disease in the cerebellum being therefore a matter which cannot be positively determined from the symptoms, any effort at its removal must necessarily be tentative. There are many cases reported of tumor of the cerebellum in which it is perfectly evident that an operation would have been successful. In these cases the tumor lay in the posterior fossa directly beneath the bone, was not adherent to the cerebellum, and could have been easily removed. An exploratory operation, therefore, would have succeeded in these cases. In a disease which is necessarily hopeless any means certainly should be used which may offer a possibility of relief. Therefore, in these cases of cerebellar tumor, even though the diagnosis be somewhat uncertain, an exploratory operation seems to be advisable.

Secondly: *The dangers and difficulties attendant upon an operation for cerebellar tumors* are much greater than for tumors of the cerebral hemispheres. The muscular tissues which have to be divided in order to lay bare the occipital bone are thick and richly supplied with blood-vessels, therefore hemorrhage is free and not easily controlled. After the muscular tissues have been cleared away and the bone laid bare, the bony surface open to operation is exceedingly limited, the sinuses leaving but a small portion of the bone open to the trephine. The part accessible is a triangle, rarely more than two inches in its greatest diameter, on each side of the median line. The opening through the occipital bone gives access to a portion of the posterior inferior surface only of the cerebellum; its anterior inferior surface and the greater part of its superior surface are wholly inaccessible. The fossa in which the cerebellum lies is small and the organ is held down into it tightly by the tentorium; it cannot therefore be freely pressed aside by the exploring

finger even in the normal state, and when the intra-cranial contents are increased by a tumor, the pressure in the fossa is so great that the opening of the skull is apt to be followed, as in my first case, by an immediate bulging of the cerebellar tissue, which prevents exploration. It is true that the cutting off of such tissue appears to cause no serious symptoms, yet it cannot be absolutely harmless. The difficulties of the operation are therefore not small.

The records of cases operated upon for cerebellar tumor are by no means encouraging. Up to the present date eleven such cases have been recorded. These are as follows:

CASE I. (Bennett May: *Lancet*, April 16, 1887, i. 768.)—Male, aged seven; suffered in April, 1886, from headache, chiefly frontal, and vomiting; then gradual failure of sight developed, and in July he was nearly blind. In July paralysis of the right sixth nerve was noticed, and the eyes were turned to the left. Optic neuritis was then found in both eyes. At this time the gait became affected; he staggered, and tended to fall backward and to the left. His mind was clear. In August the headache and vomiting became severe, he could not stand, and the head was retracted. In October he had become totally blind and nystagmus had appeared. There was loss of knee-jerk on the right side and general weakness, with great emaciation.

He was then operated upon by Mr. May. The cerebellum was exposed on the right side of the median line, and appeared to be healthy, but bulged, and was felt to be hard at one spot. After incision at this spot a tumor was felt one inch below the surface. This was dug out with the handle of a spoon. It was larger than a pigeon's egg, hard on the surface, caseating at its centre. Hemorrhage was slight, but the child died of shock a few hours afterward.

CASE II. (Horsley: *British Medical Journal*, 1887, i. 865.)—Male, aged eighteen; had suffered from headache, vomiting, optic neuritis, increasing weakness of all his limbs, especially of the left arm and leg, vertigo, and typical staggering gait of cerebellar disease. He also had epileptoid attacks, with turning of the head and eyes to the right. His mental state was good, but he was much emaciated and had been in bed a year. Dr. Bastian made the diagnosis of a tumor involving the right lobe of the cerebellum, and, as a last resort, Mr. Horsley attempted its removal. After trephining, a tubercular tumor was found in the right lobe of the cerebellum and removed. It weighed seven drachms. The patient sank gradually, and died nineteen hours after the operation.

CASE III. (Suckling: *Lancet*, 1887, ii. 656.)—Female, aged twelve; complained of headache and vomiting for eighteen months, then for nine months of increasing weakness of the right arm and leg, and then for three months of severe frontal pain over the right eye. During the last month she had noticed an inability to turn the eyes to either side, and both double and dim vision. On admission to the hospital the left pupil was found to be larger than the right; there was nystagmus on any attempt at movement of the eyes; there was loss of conjugate motion of eyes to the right, and impairment of motion to the left; there was great impairment of vision, with double optic neuritis. Weakness of right extremities with diminution of knee-jerk, staggering gait with tendency to stagger to the right and to fall forward, and marked tremor of the right arm on any motion, were found. There was a slight paralysis of the left side of the face, but the tongue deviated to the right. Headache, vertigo, and vomiting were very severe and constant. The diagnosis of cerebellar tumor was made, and an operation was considered advisable.

The occipital bone was trephined over the left side and the cerebellum exposed. It bulged out of the wound, and its tissue appeared darker and

softer than normal. A part of the cerebellar substance was cut away and the wound was dressed. The patient went into a state of collapse and died of exhaustion in forty-eight hours. The autopsy showed that the glioma had occupied the entire left lobe of the cerebellum and had invaded the middle lobe also.

CASE IV. (Maunsell: *New Zealand Medical Journal*, 1889, ii, 151.)—Male, aged eighteen; had suffered from headache, vomiting, vertigo, and cerebellar ataxia, with reeling to the right. His eyes were very prominent and his vision almost lost on account of advancing optic neuritis. His head and neck were swollen and retracted. He was deaf in the left ear and had lost his sense of smell. His pupils were dilated; he had convulsions in the right arm and leg. He had lost control of the sphincters. He was trephined on the 12th of February, 1889, over the left hemisphere of the cerebellum. An hydatid cyst, four by three inches in size, lying beneath the tentorium, was found and evacuated. He recovered from the operation, but remained in a condition of blindness and deafness.

CASE V. (Maudsley and Fitzgerald: *London Medical Recorder*, June, 1890. Quoted by Knapp.)—Male, aged twenty-eight; suffered from headache, vomiting and vertigo, and staggering gait; optic neuritis had produced blindness, and he was also deaf. There was left facial paralysis and awkwardness of the left side. He was trephined April 20, 1888, over the left lobe of the cerebellum. A solid nodule was found fixed to the bone, but this could not be removed. Much cerebellar tissue escaped from the wound. The patient recovered from the operation, but the blindness and deafness persisted.

CASE VI. (Springthorpe and Fitzgerald: *Australian Medical Journal*, November 15, 1890).—Male, aged thirteen; after a blow on the right side of the forehead, suffered from headache, vomiting, uncertain gait, optic atrophy, and convulsions beginning with head and eyes turning to the right. He was trephined over the right lobe of the cerebellum. Glioma of the middle lobe was discovered. Much serous fluid was evacuated. The glioma could not be wholly removed and the patient died of shock.

CASE VII. (Bullard and Bradford: *Boston Med. and Surg. Journ.*, April 30, 1891.)—Female, aged six; suffered from vomiting, vertigo, headache, optic neuritis, cerebellar gait, partial paralysis of the right leg, increasing later to total paralysis of all the limbs, with increase of the reflexes. The operation was undertaken for the removal of the tumor of the cerebellum, but on laying bare the bone a hole was found, over the torcular, opening into the sinus, and hemorrhage from this could not be stopped. The tumor was found at the autopsy.

CASE VIII. (Lampiasi: *Wien. med. Wochenschr.*, May 19, 1889.)—Child, aged two, general symptoms of brain tumor, optic neuritis, exophthalmus, convulsions. Exploratory trephining over the cerebellum. Failure to find the tumor. Death four days later. Tuber the size of an egg found in the left lobe of the cerebellum.

CASE IX. (Knapp and Bradford: *Journ. of Mental and Nervous Diseases*, January, 1892.)—Male, aged twenty-eight; suffered from headache, vomiting, optic neuritis, blindness, deafness, tenderness in the right temporal region, paraesthesia of the mouth and hands. He was trephined by Dr. Bradford, over the tender spot on the right temple. Nothing was found. A left hemiplegia slowly developed after the operation, and two months later he died. The tumor was found in the left lateral lobe of the cerebellum.

CASE X. (Stewart: *Pittsburg Medical Review*, November, 1892.)—Male, aged thirty-nine; suffered for eight months prior to his operation from headache, vertigo, vomiting, and a staggering gait, with tendency to fall backward. He also developed optic atrophy and great mental dulness.

Finally, he became unable to stand, or even to sit up in bed, on account of his tendency to fall backward. He also had tetanoid spasms of the neck and arms, which were worse upon the right side.

There were no cranial nerve palsies. The diagnosis being made of a tumor of the cerebellum, Dr. Stewart trephined over the left hemisphere. The cerebellum bulged greatly, but appeared to be normal, and a puncture with a

hypodermic needle failed to reveal the existence of a tumor, or of fluid. The wound was closed.

The autopsy, two days later, showed the existence of a large gumma in the right hemisphere of the cerebellum.

CASE XI. Potempski (*Italian Congress, Surgery, 1892; Annals of Surgery, December, 1892*) reports a case of supposed cerebellar tumor with characteristic symptoms in which two attempts at removal were made. At the first attempt the cerebellum was trephined on the right side; a large amount of fluid was evacuated, but palpation failed to reveal the tumor. After the wound had healed a second attempt was made by trephining over the left side; again, a considerable amount of fluid escaped, and it was thought that a hard nodule could be felt in the region of the vermiform lobe, but this could not be removed. At the time of the report the second wound had healed, but the patient was still suffering from his original symptoms.

Our own two cases bring the total number of operations for cerebellar tumors up to thirteen.

In six cases the tumor was not found at the operation, and the patient died. In one case the tumor was not found, but the patient lived up to the time of the report. In two cases the tumor was removed, but the patients died. In two cases it was found, but could not be removed, and the patients died. In one case it was found, not removed, but the patient lived. In but one case was the tumor successfully removed.

The percentage of deaths after cerebellar operations thus far has been 77 per cent., while that after cerebral operations has been 51 per cent.

**CONCLUSION.**—If we combine the results of the cerebral operations with those of the cerebellar operations, we find that the total number of patients operated upon for intra-cranial tumors has been eighty-seven, and that of these, forty, or 46 per cent., have proved successful, the patients recovering.

Experience will, doubtless, result in a more favorable outcome as time goes on, and neither neurologists nor surgeons should be discouraged in their attempts to relieve a formerly fatal disease.





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